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DESIGN AND IMPLEMENTAION OF COMPOUND CHAIN DRIVE MECHANISM IN BICYCLE

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ABSTRACT

In this world of rapidly rising population and pollution, the use of automobiles is increasing at an even faster rate. This increasing use of automobiles is continuously damaging our ozone layer which is responsible for the protection of mankind from the harmful rays of the sun. This gave an idea of improving the existing bicycles upto such an extent that they can easily replace the two wheelers. The implementation of compound chain drive mechanism in the cycle increased its speed output ratio and a speed of 40 km/hr is attainable by an average driver.

Keywords: - Bicycle, Compound Chain drive mechanism, pollution, ozone, two wheeler.

I. INTRODUCTION

In this fast paced world filled with automobiles and busy streets, bicycles still remain a very popular and common choice for the mode of transportation. Bicycles don't require any kind of fuel except muscle energy which is beneficial for us as it is a very good means of exercise. Bicycles have helped people become more fit by losing excess weight and improving their cardiovascular fitness. The exercise benefits of cycling are well known. By using the largest amount muscles in the body, bicycling allows riders to reach high aerobic heart rates that drive up the metabolism, and give a good workout.

1.1. Review work from existing bicycle-

Bicycles available nowadays can be divided into two parent categories

1.Single gear bicycles

2. Multi geared Bicycles

The speed howsoever remains somewhat limited in either case upto a max of 30km/hr in most general cases. A problem that arises here is that using these bicycles for long distances can be very tiresome and time consuming. The sprocket to gear ratio also reaches up to a max of 1: 3.0 which is again not a very high ratio. And the cost of bicycles providing such ratio starts from a minimum of 8000 rupees which isn't a very comfortable range for an average user. The research done by Shubham Dhekle et al" High speed effortless bicycle[1]" included planetary gearing mechanism and the research on the topic "Design and Fabrication of Shaft Driven Bicycle"[2] done by Ashish S. Gawande and team had shaft driving their bicycle. Both of these researches aim on effort reduction that is applied by the driver. This helps him in riding further far and that too without much difficulty and without getting tired. These works were also used for the understanding and enlightenment of the topic purposes.

1.2 Problem statement -

Limitation of maximum speed that can be attained with normal or present gear equipped cycles. Maximum speed that a fit rider could attain was 25-35km/hr for medium intervals on a well-developed surface, for example - concrete road. The cost also was a very big challenge as most of the people aren't able to afford costly bicycles.

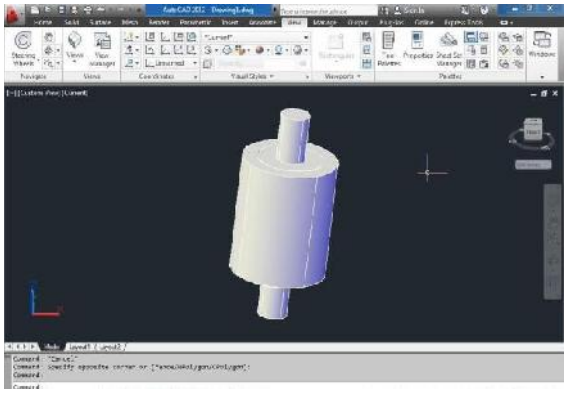
1.3 Solution approach

-Placing a compound gear chain drive arrangement along with the existing mechanism to attain a higher speed output and attain a planned ratio of 1:4.35.

II. DESIGN

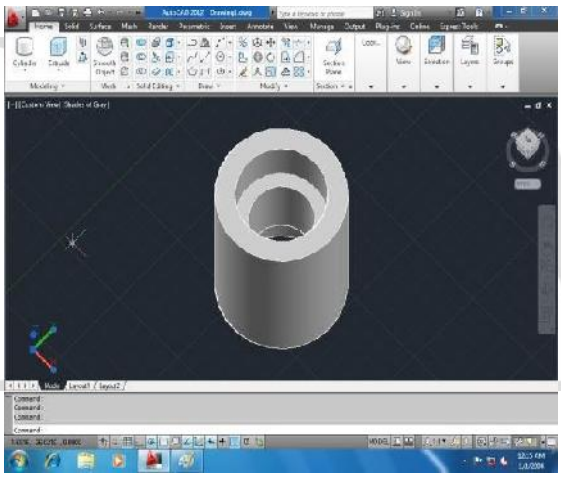
2.1 Mechanism concept -

A hollow shaft was planned in which 2 step collars were to be made that were thick enough to stop bearings from both the sides after inserting them up to a certain depth. A rod had to be then placed across the bearings and the shaft and then a pair of circlip had to be introduced at the exterior ends of the rod to stop its horizontal movement as rest were already blocked by the tight fit with the bearing. This housing then had to be placed in the cycle frame and welded parallel to the pedal mechanism that already exists in the bicycle. Sprockets of different teeth count had to be placed on either side of the rod and then the chain had to be placed in parallel with the pedal and the rear sprocket. Once the mechanism was working perfectly then permanent joints had to be introduced wherever necessary through welding[3].

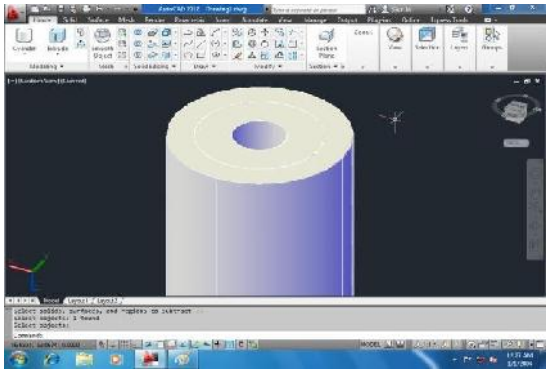


(Fig 3Arrangement of rod in the mechanism.)

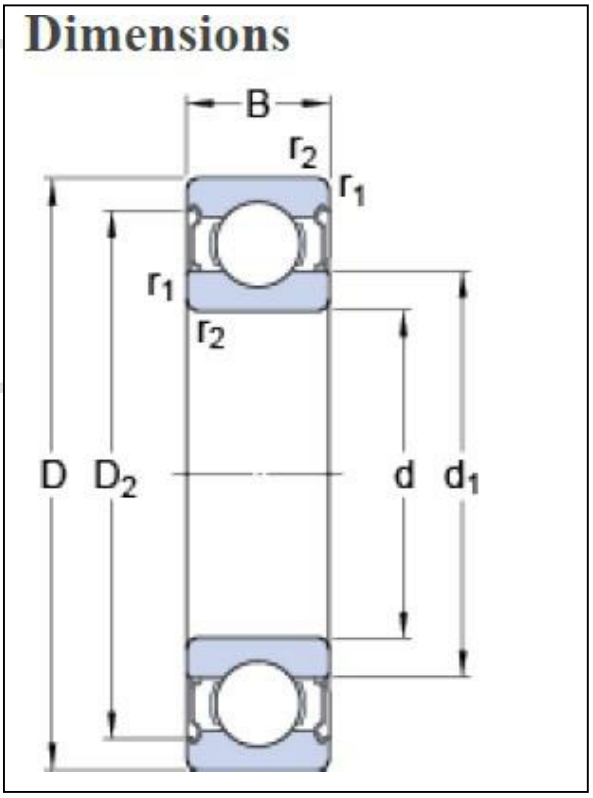
2.2 Bearings used – 6302 ZZ



(Fig 1 – Drilling a hole to reduce weight and then making collars for bearing placement.)



(Fig 2 – Arrangement of bearings on collars on both sides.)



d – 15 mm

D – 42 mm

B – 13 mm

D1 – 23.7 mm

D2 – 36.23 mm

r 1,2 – 1mm

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2.3 Fabrication-

a. *Cutting the desired length of the hollow rod*

2.4 Making Collars in the rod

2.5 Turning the shaft as per requirement-

Figure 7 turning the shaft

2.6 Attaching the bearing to the shaft and then ceasing its horizontal movement with a circlip-

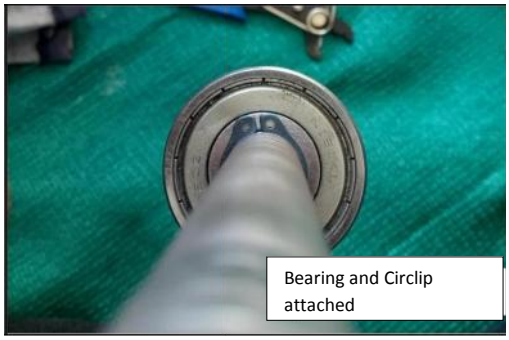

Figure 8

2.7 Getting the initial mechanism ready for final modifications –

Figure 9 modified shaft

2.8 Drive placement-

FIGURE 10 Drive placement

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III. WORKING MECHANISM

With the usage of compound gear mechanism, the overall speed output of the vehicle has increased when compared to normal or gear equipped cycles. This happened due to the fundamental principle of compound gearing mechanism which states that that the speed ratio at the end of the sprocket increases with a decrease in the torque output. Torque and speed stay inversely proportional here and with the increase in ones value, the other one is decreased.

P = T * W

where, P = power

T = torque

W = angular velocity

.The overall speed ratio achieved was 1:4.35. This had been decided on the basis of selection of the sprockets and the number of teeth upon them.

3.1 *Calculation*

Radius of drive sprocket(R) - 0.085m

Gravitational pull (g) - $9.8N/m^2$

Diameter of pedal (D) - 0.34m

Coefficient of Friction(x) - 0.7 for dry surface and 0.4 for wet surface.

For Torque produced by driver (T) – (Taking a 40 kg driver)

1) T = Effort × D
Effort = 0.15 × 40

Effort = 0.15 ×40 × 9.8 = **58.8**

2) Torque = 58.8 × 0.34 = **19.992 N-m**

3) Torque required by cycle - T =
x × W × R,

Where W = mass × gravitational pull.

Taking x = 0.7

T = 0.7 × (14 × 9.8) × 0.34= 8.16 N-m

Thus the required torque to move the cycle will be achieved easily.

IV. COST FOR FABRICATION

S.no	Part name	Material	Dimension (in mm)	Buying cost (In rupees)
1	Cycle Structure	Steel	540-560 height	1500/-
			1020 wheelbase	
2	Sprocket	Medium	Ø 130 – 32 teeth	130
			Ø 80- 18 teeth	
				100/-
		Carbon Steel	Ø 45 – 11 teeth	
3	Tires and tubes			80/-
		Rubber		
			Ø 510	700/- (for pair)
4	Chain	Low Carbon	1350 length	200/-
		Steel		
6	Pedal Pair	Plastic	94 x 82	50/- (for pair)
7	Brakes	Stainless Steel	50 mm shoes	250/- (for pair)
			Ø 50 x 100	
8	Shaft	Mild Steel	Ø 16	200/-
10	Bearings	Chrome Steel	Ø 42	200/- (for pair)
11	Circlip	Spring Steel	Ø 13	20/- (for pair)
12	Sheet	Mild Steel	1.5 thickness	120/-
13	Chain Cover	Mild Steel	----	60/-
14	Paint[4]	------	400ml x 2 cans	400/-

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Total Direct Cost – ***Rupees 4010/-***

V. OUR BICYCLE "INFUSION

Figure 11 modified bicycle

VI. ADVANTAGES AND DISADVANTAGES

6.1 Advantages -

1) Increased speed ratio.

2) Lesser pedals given and more distance covered at a rapid rate. Saves time.

3) Lower efforts required on comparison with normal and gear equipped cycle after a few pedals.

4) Significant cost reduction.

5) No or minimal weight difference from other cycles.

6) Simple design.

7) No additional major changes required in general frame.

6.2 Disadvantages -

1) Fixed gear ratio. No changes can be made

in order to change torque or RPM though gearing assembly can be installed.

2) More initial torque required in starting pedals.

3) Bit tiresome when going uphill.

VII. CONCLUSION

The resultant cycle is faster, requires a bit more effort at the starting pedals but runs easily once it catches a speed of 10km/hr approx. The cost is very affordable and in fact, cheaper than most of the cycles present in the market. The designed assembly is perfectly working and giving the required results reaching up to a speed of 32km/hr with a 45 kilograms weighted rider on a flat surface.

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